

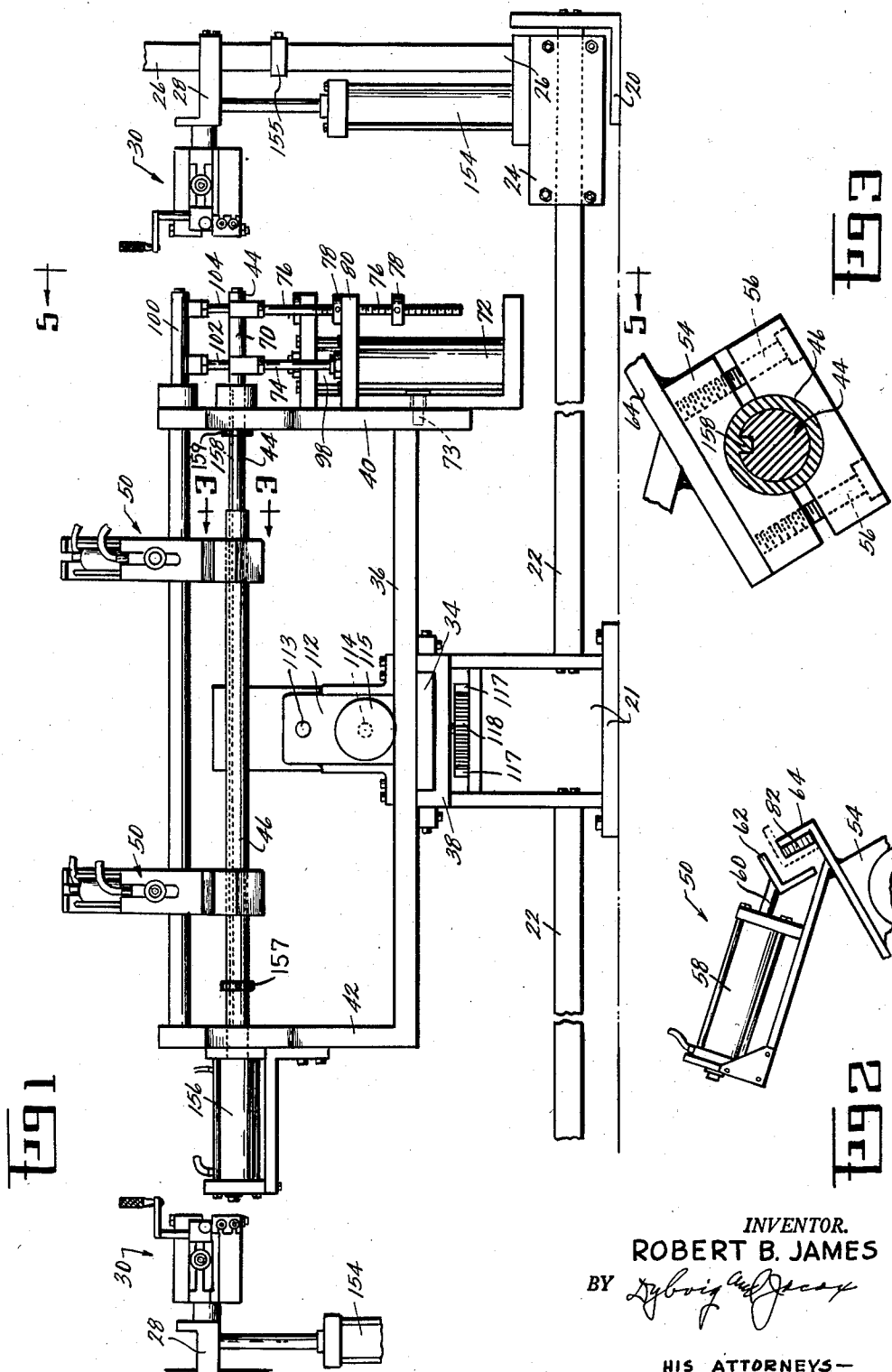
July 1, 1958

R. B. JAMES
APPARATUS FOR SPREADING A COIL AND
TWISTING THE SIDES THEREOF

2,841,200

Filed Feb. 4, 1955

4 Sheets-Sheet 1

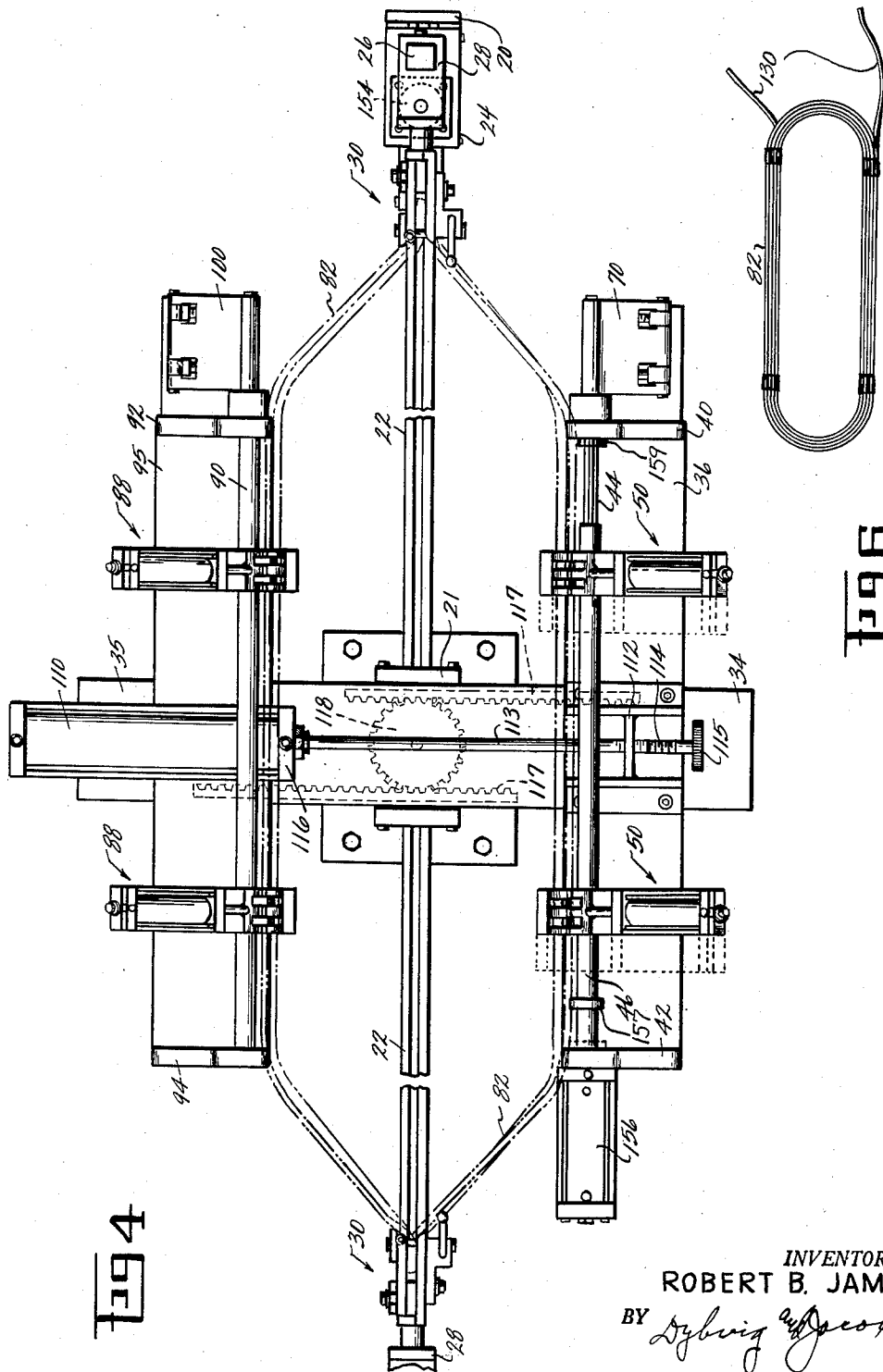


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4 Sheets-Sheet 2

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Fig 5

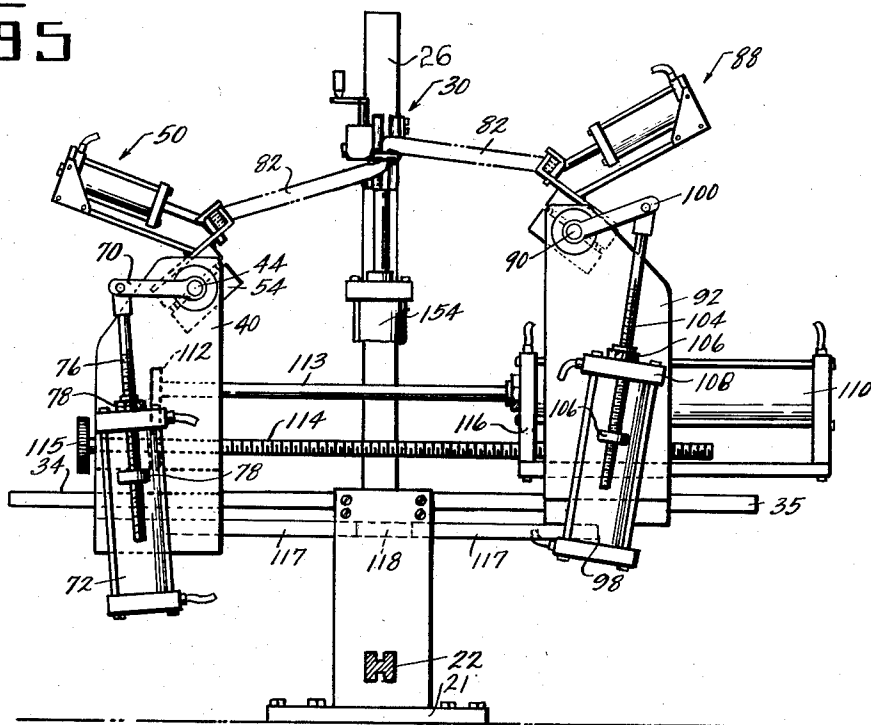


Fig 7

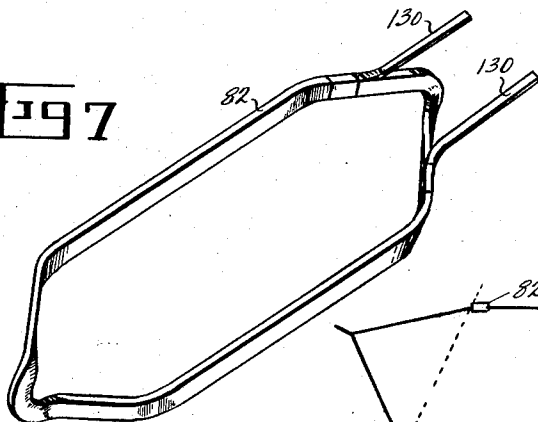


Fig 9

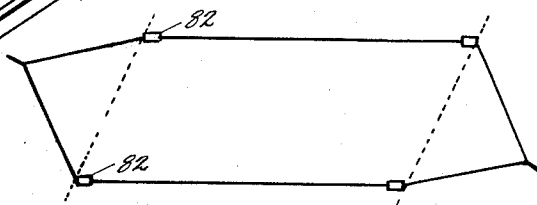
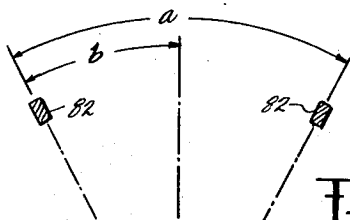


Fig 8

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Fig 10

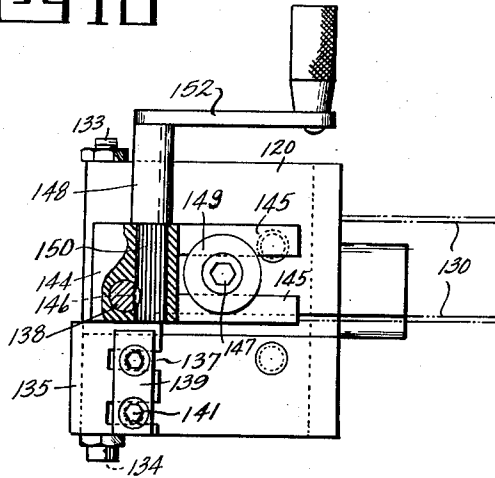


Fig 11

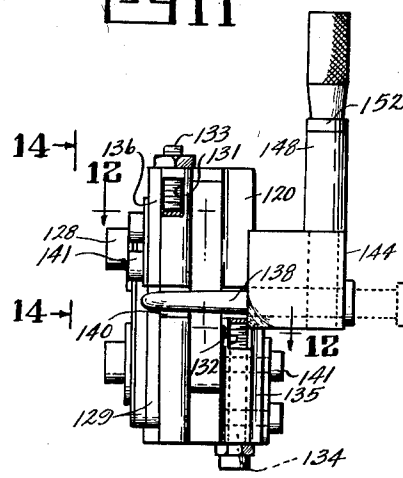


Fig 15

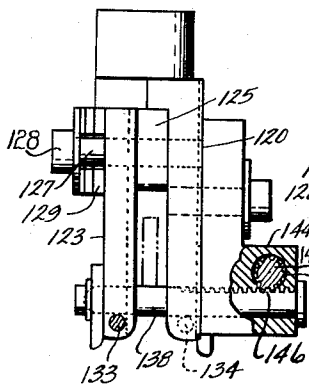


Fig 14

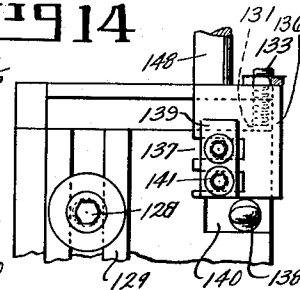


Fig 13

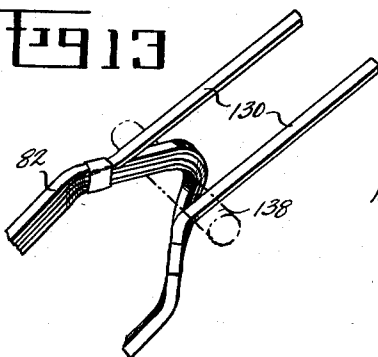
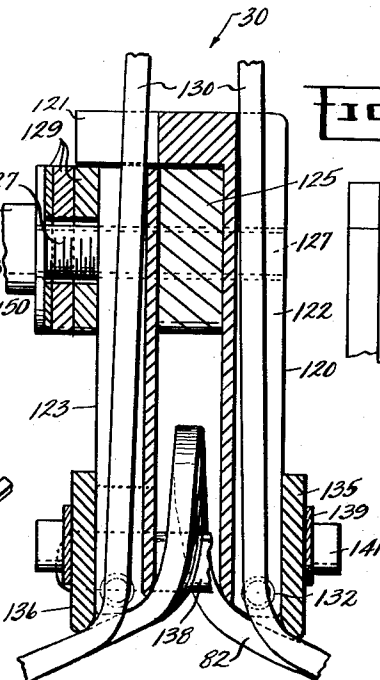


Fig 12

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APPARATUS FOR SPREADING A COIL AND TWISTING THE SIDES THEREOF

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Application February 4, 1955, Serial No. 486,126

8 Claims. (Cl. 153—6)

This invention relates to a coil forming apparatus and more particularly to a coil forming apparatus used in forming a coil for insertion into slots of an electric machine, but the invention is not so limited.

This invention relates to the disclosures set forth in my United States Letters Patent No. 2,506,219 and No. 2,451,222.

An object of this invention is to provide a coil forming apparatus that spreads a coil to the proper width and twists or deflects the sides of the coil so that the sides of the coil have the proper angular relationship to fit radially into slots of an electric machine.

In the past it has been customary to manually bend or form terminal leads after the coil is formed. This forming of the terminal leads of coils is usually very difficult due to the fact that most of the wire used for coils is rectangular in cross section and most of the bending operation must be along the longitudinal axis of the wire. Hence, an object of this invention is to provide a coil forming apparatus which has means for properly forming the coil terminal leads during the forming of the coil.

Another object of the invention is to provide a coil forming apparatus having means for motor operation thereof.

Another object of the invention is to provide a coil forming apparatus which has means for longitudinally moving one coil side with respect to the other coil side so that the coil is properly formed for positioning into skewed or angular coil slots.

Another object of the invention is to provide a coil forming apparatus having means for forming coils of various sizes.

Other objects and advantages reside in the construction of parts, the combination thereof and the mode of operation, as will become more apparent from the following description.

In the drawings—

Figure 1 is a fragmentary side elevational view of the coil forming apparatus of this invention.

Figure 2 is a side elevational view showing the clamping means for the sides of a coil.

Figure 3 is a sectional view taken substantially on line 3—3 of Figure 1.

Figure 4 is a top plan view of the coil forming apparatus of this invention.

Figure 5 is a sectional view taken substantially on line 5—5 of Figure 1.

Figure 6 is a view showing substantially the shape of a typical coil before it is formed by an apparatus of this invention.

Figure 7 is a perspective view showing a typical coil after it is formed by the coil forming apparatus of this invention.

Figure 8 is a diagrammatic view showing the manner in which the coil sides of a coil may be radially formed by the coil forming apparatus of this invention.

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Figure 9 is a diagrammatic view showing the configuration of a coil formed by the apparatus of this invention for an electric machine having skewed coil slots.

Figure 10 is a side elevational view with parts broken away of a coil end holder or knuckle holder of a coil forming apparatus of this invention.

Figure 11 is a front elevational view of a coil end holder or knuckle holder of a coil forming apparatus of this invention.

Figure 12 is an enlarged sectional view taken substantially on line 12—12 of Figure 11.

Figure 13 is a fragmentary perspective view showing an end of a coil which is provided with terminal leads and showing means for retaining the end of the coil during formation thereof.

Figure 14 is a fragmentary side view taken substantially on line 14—14 of Figure 11.

Figure 15 is a top elevational view with parts shown in section of a knuckle holder device of the coil forming apparatus of this invention.

Referring to the drawings in detail, the coil forming apparatus of this invention comprises a pair of bracket members 20 which are adapted to be rigidly secured to a work table or to a work bench or to any other suitable supporting structure. Only one of the bracket members 20 is illustrated, the left hand member being omitted from Figures 1 and 4. Intermediate the brackets 20 is a support base 21. Horizontally mounted between each of the brackets 20 and the support base 21 is a rail member 22. Movably supported upon each rail 22 is a carrier block 24. Vertically supported by each of the carrier blocks 24 is a post 26.

A support block 28 is slidably attached to each of the posts 26. To each of the support blocks 28 is attached a knuckle holder or coil end holder 30. Each of the knuckle holders 30 is adapted to retain an end portion of a coil member as discussed below.

The coil forming apparatus includes means for expanding the distance between the sides of a coil and for twisting or deflecting the sides of the coil of wire into proper angular relation.

Attached to the support base 21 is a pair of support plates 34 and 35 which extend in a direction normal to the rails 22. A carriage 36 is movably mounted upon the plate 34 by means of a retainer 38 which is secured to the carriage 36 at the lower side thereof and slidably engages the plate 34.

At one end of the carriage 36 is a vertically extending flange plate 40. At the other end of the carriage 36 is a vertically extending flange plate 42. Rotatably supported by the flange plate 40 is a shaft member 44 which is telescopically inserted into a tubular member 46 which is rotatably supported by the flange plate 42.

Mounted upon the tubular member 46 are a pair of clamping members 50 which are adjustably secured to the tubular member 46 by means of an attachment block 54, which employs a plurality of bolt members 56, as shown in Figure 3. Each clamping member 50 includes a fluid motor 58 which is provided with a piston rod 60 and a movable jaw 62 which cooperates with a stationary jaw 64. The structure of the clamping member 50 may be as described in the aforementioned patent, No. 2,506,219.

The shaft member 44 is rotated by means of a crank or lever arm 70 attached thereto. A fluid motor 72 operates the crank arm 70. The fluid motor 72 is pivotally supported by a bolt 73 which enters the flange plate 40, as shown in Figure 1. The fluid motor 72 has a piston rod 74 attached to the lever arm 70.

The rotational movement of the lever arm 70 is adjustably limited by means of a rod member 76 threaded a portion of the length thereof and provided with a pair of

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adjustment nuts 78. The adjustment nuts 78 are adapted to engage an abutment plate 80 to limit the rotational movement of the lever arm 70 as the lever arm 70 is actuated by the fluid motor 72.

The clamping members 50 are adapted to clamp one side of a coil, such as coil 82, for spreading the distance between the sides of the coil as shown in Figures 4 and 5. The other side of the coil 82 may be clamped by a pair of clamping members 83 which are similar to clamping members 50.

The clamping members 38 are adjustably attached to a rotatably mounted shaft 90 which is supported by flange plates 92 and 94 upon a carriage 95. The carriage 95 is similar to the carriage 36 and is slidably supported upon the support plate 35. The shaft 90 extends from the flange plate 92 to the flange plate 94 and is journaled therein by any suitable means.

The shaft 90 is rotatably actuated by means of a fluid motor 98 which is pivotally attached to the flange plate 92 and operates a lever arm 100 which is attached to the rotatable shaft 90. The fluid motor 98 operates a piston rod 102, and the rotational movement of the rotatable shaft 90 is adjustably limited by means of a threaded rod 104 which is similar to the threaded rod 76. A pair of nuts 106 are threadedly attached to the rod 104 and are positioned on either side of an engagement plate 108 through which the rod 104 slidably extends. The threaded rod 104 in cooperation with nuts 106 and the engagement plate 108 limits the amount of rotational movement of the shaft 90 as the shaft 90 is operated by the fluid motor 98.

As best shown in Figures 4 and 5, the carriage members 36 and 95 may be moved one from the other and one toward the other by means of a fluid motor 110 which is attached to the carriage member 95. Also, attached to the carriage 36 is a brace member 112 through which is movably inserted a threaded rod 114. The fluid motor 110 has a piston rod 113 threadedly attached to the brace member 112. The rod 114 is provided with a head 115 and is freely slidable through the brace member 112, but the portion of the rod 114 which is opposite the head 115 is threadedly secured to a vertical bracket 116 which supports one end of the fluid motor 110. The head 115 acts as an adjustable abutment stop to limit the movement of the carriage 95 from the carriage 36 for obtaining the proper distance of spread between the sides of a coil. The position of the head 115 may, of course, be adjusted by threaded movement of the rod 114 within the bracket 116.

In order to insure that the carriages 36 and 95 always travel equal distances upon actuation of the fluid motor 110, a pair of rack gear members 117 are provided, there being one rack gear member 117 attached to each of the carriage members 36 and 95. An idler pinion 118 is rotatably mounted at the central portion of the apparatus in meshed engagement with the rack gear members 117.

As stated above, the knuckle holders 30 are adapted to retain the ends of a coil during the forming process thereof. After a coil is wound and before the forming process occurs, the shape of a typical coil 82 may appear as shown in Figure 6. When it is desired to properly form such a coil, the members of the coil forming apparatus are operatively positioned to receive a coil. The carriage members 36 and 95 are actuated by the fluid motor 110 to move one carriage member toward the other until the two pairs of clamping members 88 and 50 are brought to a position in which each pair of clamping members is adjacent the center portion of the coil forming apparatus and each of the clamping members is substantially in alignment with the posts 26. In this position the clamping jaws 62 and 64 of the pair of clamping members 50 are disposed below the clamping jaws of the clamping members 88.

The knuckle holder or coil end holder 30 comprises an L-shaped bracket 120 provided with legs 121 and 122.

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The knuckle holder 30 also includes a plate member 123 which cooperates with the L-shaped bracket 120 to provide an adjustable bifurcated member. A spacer block 125 is positioned between the plate 123 and the leg 122 of the bracket 120 and a bolt 127 provided with a head 128 retains the plate 123 to the bracket 120, as best shown in Figure 12. A plurality of spacer shims 129 are carried by the bolt 127. Any of the shims 129 may be removed from between the head member 128 and the plate 123 and placed alongside of block 125 between the leg 122 and the plate 123 for adjustment of the space between the leg 122 and the plate 123.

The coil 82 is provided with terminal leads 130. It is desirable to have the terminal leads 130 disposed at proper angular relationship with respect to the coil 82 after the coil 82 has been formed by the coil forming apparatus of this invention. Therefore, the knuckle holder 30 is provided with a pair of slots, there being a slot 131 in the plate 123 at the upper portion thereof and a slot or channel 132 in the leg 122 adjacent the midportion thereof.

The slots 131 and 132 are adapted to receive the terminal leads 130 when the coil 82 is placed into the coil forming apparatus for the forming thereof. A set screw 133 extends into the slot 131 and a set screw 134 extends into the slot 132 as best shown in Figure 11. These set screws 133 and 134 act as clamping members to retain the terminal leads 130 within the slots 131 and 132, as clearly shown in Figures 11 and 12. By adjustment of the space between the plate 123 and the leg 122 of the knuckle holder 30, the desired spacing between the terminal leads 130 may be obtained.

Attached to the leg 122 of the L-shaped bracket 120 is a shoulder block 135 and attached to the plate member 123 is a shoulder block 136. Each of the shoulder blocks 135 and 136 is provided with slots 137 and is adjustably held by retainer plates 139 and a plurality of bolts 141, and is adapted to be engaged by the coil member 82 during the spreading of the distance between the sides of the coil so that the curvature of the coil is properly formed adjacent the ends thereof.

The coil 82 which is to be formed by the coil forming apparatus is positioned in the apparatus so that the terminal leads are disposed within the slots 131 and 132 of the knuckle holder 30 as described above. The coil 82 is placed within the apparatus so that the two sides of the coil are disposed substantially in the same vertical plane. Therefore, the ends of the coil may be inserted into the space between the plate 123 and the leg 122 of the knuckle holders 30.

The ends of the coil constitute loops through which a pin 138, which is movably attached to the leg 122, may be inserted. The pin member 138 is horizontally movable between the leg 122 and the plate 123 and is extendable into a notch 140 of the plate 123 as best shown in Figures 11 and 15.

The pin 138 is slidably journaled in a bearing bracket 144 attached to the leg 122 of the knuckle holder 30. The bearing bracket 144 has a pair of spaced-apart legs 145 which are secured to the leg 122 by means of a bolt 147 and washers 149. The pin 138 is provided with a series of teeth 146. A vertical shaft 148 extends into the bearing bracket 144 and is rotatable therein. The shaft 148 has a plurality of radial pinion gear teeth 150 which cooperate with the rack gear teeth 146 of the pin 138. Thus, the pin 138 may be longitudinally moved by means of the shaft 148 which is provided with a handle 152. Thus, as the pins 138 of the knuckle holders 30 extend through the loops formed at the respective ends of the coil 82, the ends of the coil 82 are firmly retained by the knuckle holders 30.

It is to be understood that the terminal leads 130 extend from only one end of the coil 82 as clearly shown in Figures 6 and 7. Therefore, only one of the knuckle holders 30 receives the terminal leads 130.

The coil 82 being substantially vertical as it is placed into the knuckle holders 30, the carriage members 36 and 95 are moved to juxtaposed position so that the clamping members 50 and 88 are substantially at the center portion of the coil forming apparatus. The clamping members 50 and 88 are then substantially above the rail members 22 with the clamping members 50 being disposed below the clamping members 88. The clamping members 50 and 88 are actuated by their respective fluid motors so that the sides of the coil 82 are grasped by the clamping jaws 62 and 64 of the clamping members 50 and 88 as shown in Figure 2. The coil 82 is thus positioned in the coil forming apparatus for the forming thereof.

The fluid motor 110 is then actuated to move the carriages 36 and 95 outwardly from the center of the machine. This forces the sides of the coil one from the other and sets the spacing between the sides of the coil. This spreading movement also forces the portions of the coil adjacent the ends thereof against the shoulder blocks 135 and 136 of the knuckle holders 30 for proper formation of the coil ends. The amount of movement of the carriage members 36 and 95 is limited by engagement of the head 115 of the rod member 114 against the brace member 112 as described above.

The fluid motors 72 and 98 are actuated to rotate the shafts 44 and 90, respectively, deflecting the sides of the coil 82 so that the sides of the coil have a common axis and the coil may be radially inserted into the coil slots of stators or rotors of electric machines. The amount of deflection of the coil sides is determined by preadjustment of the nuts on the rods 76 and 104. In Figure 8 is shown diagrammatically the manner in which the coil sides of a coil may be angularly twisted or deflected so that the coil sides are radially disposed upon the same center.

Vertical movement of the knuckle holders 30 during the coil forming operation is obtained by means of fluid motors 154 one of which is attached to each of the movable support blocks 28. The vertical movement of the knuckle holders 30 is limited by means of adjustable stops 155 which are abuttingly engaged by the support blocks 28. Thus, the knuckle holders 30 properly form the ends of the coil including the terminal leads 130 at one end thereof. The shoulder blocks 135 and 136 cause the portions of the coil adjacent the ends thereof to be formed to the proper curvature as the sides of the coil are forced one from the other by the fluid motor 110.

After the coil 82 has been properly formed by the coil forming apparatus of this invention, the coil may be removed therefrom by removal of the pin 138 of the knuckle holders 30 from the loop at each end of the coil 82. Also for removing the coil 82 after it is formed, the clamping members 50 and 88 are deactuated followed by movement of the carriages 36 and 95 one toward the other by actuation of the fluid motor 110.

In some types of electric motors and generators, the coil slots are angularly disposed or skewed with respect to the longitudinal axis thereof. In the past it has been difficult to properly form a coil which is to be placed into skewed slots.

In the machine of this invention a fluid motor 156 is attached to the flange plate 42. The tubular member 46 acts as a piston rod for the fluid motor 156. Thus, the tubular member 46 may be longitudinally moved by the fluid motor 156. Therefore, during the coil forming operation, the fluid motor 156 may be actuated to move the tubular member 46 as it telescopically encircles the shaft member 44. The movement of the tubular member 46 is thus guided by the shaft member 44. This longitudinal movement of the tubular member 46 is adjustably limited by a stop member 157 clamped upon the tubular member 46 and by a stop member 159 clamped upon the shaft member 44. As the tubular member 46

moves longitudinally, it carries the clamping members 50 which are attached thereto. Thus, one side of the coil 82 is moved longitudinally with respect to the other side of the coil, and the coil is properly formed to be placed into skewed slots and the coil appears as diagrammatically shown in Figure 9.

The tubular member 46 is provided with an inwardly extending longitudinal projection or key 158 which cooperates with a longitudinal slot in the shaft 44, so that as the shaft 44 is rotated by the fluid motor 72 the clamping members 50 are caused to rotate providing the proper angular relationship to the side of the coil held by the clamping members 50.

It may be understood that as a result of the provision for numerous adjustments, the coil forming apparatus of this invention may be employed to form coils of many different sizes. The screws 133 and 134 are adapted to provide clamping action to the terminal ends regardless of the size of the wire employed. The coils may be formed for skewed slots or for slots which are not skewed. The angle of curvature at the portions adjacent the ends of the coils is adjustable by changing the amount of projection of the shoulder blocks 135 and 136 with respect to their mounting means.

The coil forming apparatus of this invention may have many other applications than that of forming coils for electric machines.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. A coil forming apparatus for use in spreading a coil so that the coil can fit into radially directed skewed slots arranged in angular spaced relation, said apparatus comprising supporting structure, a pair of bracket members attached to the supporting structure, the bracket members being disposed in spaced relation, a support base intermediate said bracket members, a pair of rail members, one of said rail members joining each bracket member to the support base, a carrier block movably supported upon each of said rail members for movement thereon, a post vertically supported by each of said carrier members, a support block slidably movable upon each post member, a clamping member attached to each support block for engaging the ends of a coil, each clamping member being provided with a pair of vertical plate members, means for adjusting the distance between the vertical plate members, a pin member adjustably and longitudinally movable between said vertical plate members, a support plate attached to said support base member, the support plate being disposed normal to said rail members and extending on each side thereof, a pair of carriage members slidably attached to said support plate, there being one carriage member on each side of said support base, fluid motor means for movement of said carriage members upon said support plate in opposite directions, the carriage members being movable toward and away from the rail members, a shaft member rotatably carried by each of said carriage members, fluid motor means for rotation of each of said shaft members, a plurality of clamping members attached to each of said shaft members for engaging the sides of a coil, and fluid motor means attached to one of said shaft members for axial movement thereof.

2. In a device for retaining the end of a coil provided with terminal leads during the forming of said coil comprising a bracket member provided with a pair of legs attached one to the other and normal one to the other, a plate member cooperable with the bracket member and adjustably attached thereto, the plate member being

mounted normal to one of the legs of the bracket member and parallel to the other leg of the bracket member, the plate member being in spaced relation to the leg of the bracket member with which it is parallel, the plate member being provided with a longitudinal slot therein and the leg of the bracket member parallel to the plate member also being provided with a longitudinal slot therein, said slots being substantially parallel one to the other and adapted to receive the terminal leads of the coil, means for clamping a terminal lead within each of the slots, a pair of forming blocks, one of said forming blocks being attached to the plate member and the other of said forming blocks being attached to the leg of the bracket member which is parallel to the plate member, each of said forming blocks being provided with an arcuate edge portion, the arcuate edge portion of each of said forming blocks being adapted to engage a portion of the coil during the forming of the coil, means for adjustment of each of the forming blocks, a pin member movable between the plate member and the leg of the bracket member which is parallel thereto, and gear means for longitudinal movement of said pin member.

3. A clamping device for retaining and forming the terminal leads of an electrical coil during the formation of the coil, the combination comprising a bracket member provided with two plate members adjustably attached one to the other in substantially parallel relationship, each of said plate members being provided with a channel therein adapted to receive a terminal lead of the coil, an adjustably mounted shoulder block attached to each of said plate members adjacent the channel thereof, a bearing housing attached to one of said plate members, a pin member slidably carried by said bearing housing, the pin member being provided with a series of teeth, a shaft member extending into the bearing housing, the shaft being provided with a plurality of teeth in engagement with the teeth of said pin member, rotation of said shaft thus causing axial movement of said pin member, the pin member being extendable from the bearing housing and extendable from one plate member to the other plate member.

4. A clamping device for a coil for retaining an end of said coil provided with terminal leads during the formation thereof, the combination comprising a bracket member provided with two plate members adjustably attached one to the other in substantially parallel relationship, each of said plate members being provided with a channel therein adapted to receive a terminal lead of the coil, means for securing a terminal lead within each channel, an adjustably mounted shoulder block attached to each of said plate members adjacent the channel thereof, a bearing housing attached to one of said plate members, a pin member slidably carried by said bearing housing, the pin member being provided with a series of transverse teeth, a shaft member extending into the bearing housing normal to the pin member, the shaft being provided with a plurality of radial teeth in engagement with the teeth of said pin member, rotation of said shaft thus causing axial movement of said pin member, the pin member being extendable from the bearing housing of the plate member to which it is attached and extendable to the other plate member.

5. A coil spreading apparatus for use in spreading a flatly wound coil provided with extending terminal leads so that the coil can fit into radially directed slots arranged in angular spaced relation, comprising a pair of adjustable terminal lead clamping members for retaining the terminal leads of the coil in proper predetermined locations one with respect to the other and with respect to the coil, each of the terminal clamping members having a pair of channels for receiving the terminal leads, a pair of carriages, a pair of rotatably mounted shaft members, there

being a rotatably mounted shaft member carried by each of said carriages, a plurality of clamping members secured to each of said shaft members, the clamping members being adapted to grasp the sides of the coil, one of said shaft members being axially movable to longitudinally move one side of the coil with respect to the other side of the coil, fluid motor means for axially moving said axially movable shaft, and fluid motor means for moving the terminal lead clamping members along a line transverse to the axis of the shaft members.

6. A coil forming apparatus for use in spreading a flatly wound coil so that the coil may fit into radially directed skewed slots arranged in angular spaced relation, the combination comprising a supporting structure, a pair of elongate carriage members movably attached to said supporting structure, each of the carriage members having a bearing support member adjacent each end thereof, fluid motor means for lateral movement of the carriage members, a pair of shaft members, there being one shaft member rotatably carried by the bearing support members of each of said carriage members, a plurality of clamping members attached to each of said shaft members for engaging the sides of a coil, and fluid motor means for axial movement of one of said shaft members so that one side of a coil is moved longitudinally with respect to the other side of the coil.

7. In a coil forming device comprising support structure, a pair of elongate carriage members disposed in parallel relationship mounted upon said support structure, means for moving each of said carriage members toward and away from the other carriage member, a pair of elongate shafts, there being an elongate shaft rotatably supported by each of said carriage members in substantially parallel relation to the longitudinal axis thereof, a clamping member attached to each of said rotatable shaft members, means attached to each of the shaft members for rotation thereof, and reciprocal means attached to one of the shaft members for axial movement thereof.

8. A clamping device for retaining and forming the connection leads of an electrical coil during the formation of the coil, the combination comprising a bracket member provided with a plurality of plate members adjustably attached one to the other, each of the plate members being provided with a channel therein adapted to receive a connection lead of the coil, a bearing housing supported by one of said plate members, a pin member slidably carried by said bearing housing, rotatable means engaging said pin member for axial movement thereof, the pin member being extendable from the bearing housing from one plate member to another plate member, the pin member being adapted to move between two portions of a coil to retain the coil against bodily movement during forming thereof while the connection leads of the coil are retained in the channels of the plate members.

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